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POPULATION MONITORING OF THE HAWAIIAN MONK SEAL, *Monachus schauinslandi*, AND CAPTIVE MAINTENANCE PROJECT AT KURE ATOLL, 1988

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U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Southwest Fisheries Science Center

NOAA Technical Memorandum NMFS

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John R. Henderson
Michael R. Finnegan

Southwest Fisheries Science Center Honolulu Laaboratory
National Marine Fisheries Service, NOAA
Honolulu, Hawaii 96822-2396

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U.S. DEPARTMENT OF COMMERCE
Robert A. Mosbacher, Secretary
National Oceanic and Atmospheric Administration
John A. Knauss, Under Secretary for Oceans and Atmosphere
National Marine Fisheries Service
William W. Fox, Jr., Assistant Administrator for Fisheries

ABSTRACT

Data on the Hawaiian monk seal, *Monachus schauinslandi*, were collected at Kure Atoll from 23 February to 20 October 1988. Beach counts made on 54 atoll-wide censuses averaged 30.0 seals, including pups of the year. Eight pups (five females and three males) were born; seven survived to weaning. Thirteen injuries to 12 seals were documented, and 5 seals became entangled in marine debris. An estimated 1,195 kg of debris were removed from beaches. Thirty-two of 40 seals tagged at Kure Atoll since 1981 were resighted. Five weaned female pups were maintained in a protective enclosure until 20-21 September, and a yearling Kure Atoll seal, which had been rehabilitated in Honolulu, was maintained in the enclosure from 22 March to 12 May.

CONTENTS

	Page
Introduction	1
Methods	1
Censuses	1
Tagging	3
Captive Maintenance Program	3
Inventory of Debris	3
Results	4
Counts and Distribution	4
Tagging	6
Reproduction	6
Captive Maintenance Program	8
Injuries	9
Mortalities	11
Tag Resightings	11
Kure Atoll Seals	11
Interatoll Movement	11
Entanglements	12
Debris	14
Discussion	15
Acknowledgments	16
Citations	16
Appendixes	19

INTRODUCTION

Kure Atoll, the most northwestern end of the Hawaiian Archipelago, is also the northernmost haul-out and breeding site of the Hawaiian monk seal, *Monachus schauinslandi*. The atoll consists of a circular fringing reef approximately 9 km in diameter, enclosing a lagoon, one permanent land mass (Green Island), two sand islets (Sand and Shark Islets), and a sometimes emergent area known locally as Stark Reef (Fig. 1). Green Island is the site of a U.S. Coast Guard (USCG) loran station, commissioned in 1961 and staffed by 20-30 USCG personnel.

The monk seal population at Kure Atoll, as evidenced by beach counts of seals, declined almost 70% from 1957-58 to 1978 (Kenyon and Rice 1959; Rice 1960; Johnson et al. 1982). This decrease included a period of low pup survival (Wirtz 1968) that has been attributed to the abandonment of favored historical pupping beaches on Green Island. Parturient seals instead gave birth on less favorable sand spits such as Sand Islet (Kenyon 1972). The low survival of pups resulted in low recruitment of females and a decline in pup production from the mid-1960s to 1986 as the aged females died (Gilmartin and Gerrodette 1986). Since 1981, pup survival increased dramatically.

In 1981, a research and recovery program was initiated by the Southwest Fisheries Science Center Honolulu Laboratory of the National Marine Fisheries Service (NMFS), NOAA, to enhance first-year survival of weaned pups (Gilmartin et al. 1986). The annual project includes temporary maintenance of weaned female pups born at Kure Atoll, identification of parturient female seals, regular censuses of the seal population (including resightings of tagged seals), and inventory and removal of debris capable of entangling wildlife from the beaches and lagoon. The program was expanded in 1984 to include maintenance and release of female yearlings collected from French Frigate Shoals as undersized pups and rehabilitated in captivity. This report summarizes activities conducted under this program at Kure Atoll in 1988.

METHODS

Censuses

Censuses of seals were conducted approximately three times weekly from 15 March to 16 September 1988. Counts included Green Island and Sand and Shark Islets except when inclement weather or outboard engine failure prevented travel within the lagoon. Censuses commenced on Green Island between 1200 and 1300 (Hawaii standard time). Data from Green Island were collected by two-person teams, either in tandem if one observer was being trained, or split if both were experienced in census procedures and size assessment of seals. Data from Sand and Shark Islets were collected by a single observer. Stark Reef was censused at irregular intervals from a boat and was awash after mid-July. All other procedures followed those described by Reddy (1989), except that during split censuses of Green Island, each observer would continue his transit until meeting his counterpart, regardless of the geographic location on the island. Observers changed throughout the study (Appendix A).

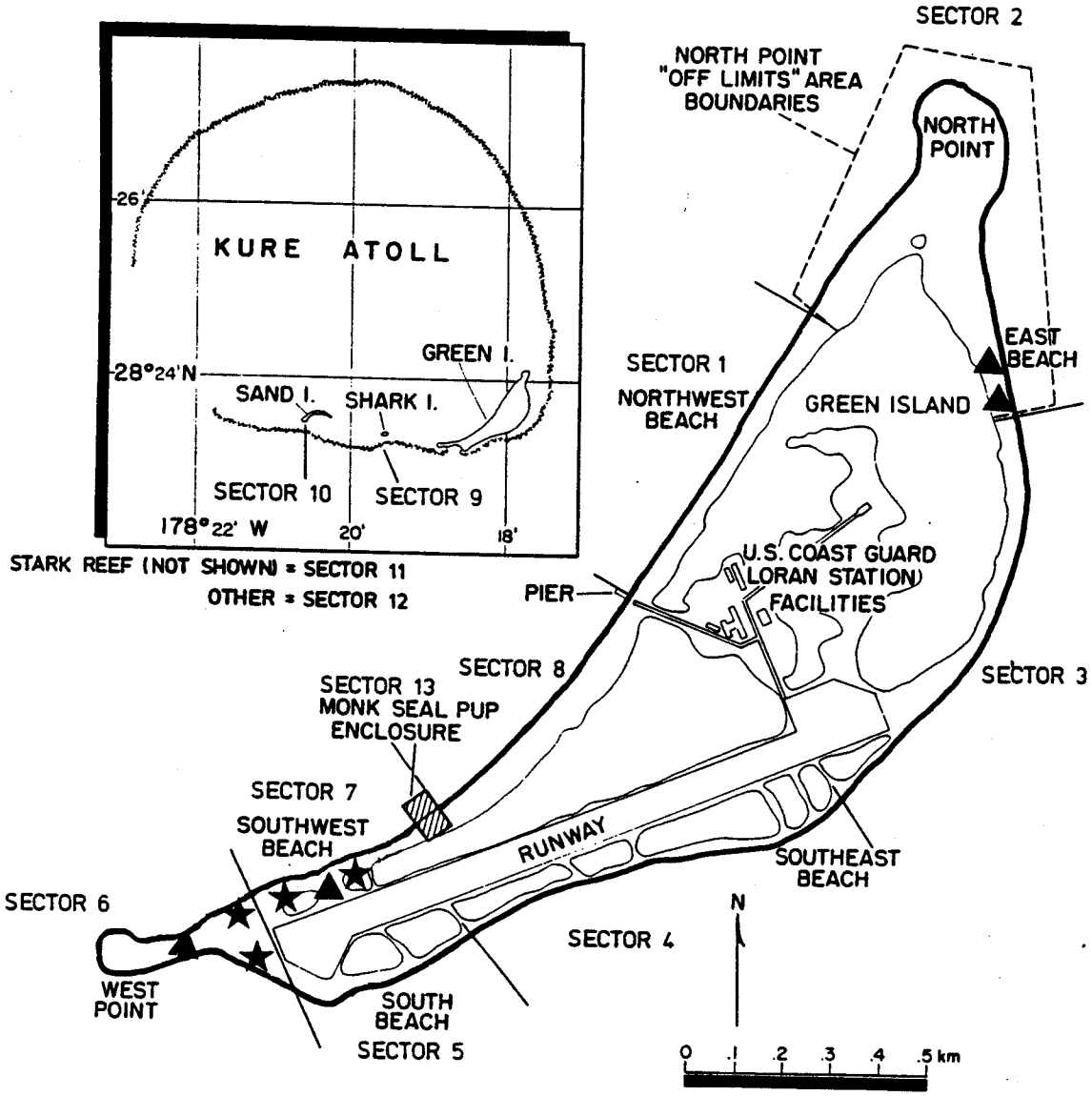

Figure 1.--Map of Kure Atoll and Green Island, showing the Hawaiian monk seal enclosure site, sector divisions, and 1988 pupping sites (triangles equal known pupping sites; asterisks equal presumed pupping sites).

All beaches at Kure Atoll were divided into sectors to record the location of seals (Fig. 1). Green Island included sectors 1-8 and 13 (the ocean-beach enclosure). Sectors 9-12 comprised Shark Islet, Sand Islet, Stark Reef, and other locations such as offshore reefs. Lengths of sectors on Green Island were measured to determine the density of seals and debris.

Tagging

All successfully weaned pups were tagged with gray Temple Tags[1] according to procedures described by Gilmartin et al. (1986) and Reddy (1989). Tags were inscribed with an *F*, designating 1988, followed by a unique two-digit number. Lost or broken tags on older seals were replaced with numbered tags bearing the letter appropriate to the year of original tagging.

Captive Maintenance Program

An ocean-beach enclosure of wire mesh, 38 x 52 m, to maintain seals was constructed on the southwest side of Green Island (Fig. 1). The fencing of the enclosure was cleaned weekly and repaired as necessary throughout the season. Female pups born and weaned at Kure Atoll were collected, measured, tagged, weighed, and placed in the enclosure. Straight length was measured dorsally. Pups were weighed with a hanging scale approximately every 30 days while in temporary captivity. Also placed in the enclosure was a yearling female (ID KN88) which was born at Kure Atoll in 1987 and maintained in captivity in Honolulu until early 1988 when it was returned to the atoll. No rehabilitated yearlings from French Frigate Shoals were maintained in the pen or released at Kure Atoll in 1988, since no underdeveloped pups were collected in 1987.

Live reef fish and invertebrates, caught by hook and line or in traps at various sites within the lagoon, were added to the enclosure daily. The amount and composition of the catch varied, but live fish were always available to the seals. In a procedure to dissociate feeding from the presence or sound of the boat, the catch was temporarily placed in a buoyed wire mesh box (ca. 1.0 x 1.0 x 0.5 m) which was moored just outside the enclosure; catch was added to the enclosure later the same day or the following morning.

Inventory of Debris

Nets, lines, and other flotsam that could entangle wildlife were cataloged, measured, accumulated at sites on Green Island or Shark Islet away from wildlife and vegetation, and burned. Items considered hazardous are detailed in Reddy (1989) and included all nets or

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[1] Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

net fragments, lines of any length that formed a loop, unlooped lines longer than 1 m and thinner than 90 mm (diameter), and rings of any material with sufficient diameter to encircle the muzzle or flipper of a monk seal.

RESULTS

Counts and Distribution

Fifty-four atoll-wide censuses were conducted from 15 March through 16 September 1988 (Appendix B). The number of seals, excluding pups averaged 25.4 (SD = 6.27); the average count for all seals was 30.0 (SD = 6.65). On average, about two-thirds (64.6%) of the seals were hauled out on Green Island, while the remainder (35.4%) were hauled out on Sand and Shark Islets and Stark Reef. The ratio of immature to adult seals in the census beach counts was approximately equal (13.0:12.7).

Because previous beach counts may include different time periods, comparisons of beach counts among years have included only data collected between 1 April and 31 July (Gilmartin and Gerrodette 1986). Mean counts for this period in 1988 averaged 30.5 (SD = 6.66): 12.7 adults, 13.0 subadults and juveniles, and 4.8 pups. This count is higher than any comparable count from 1981-86 (Gilmartin and Gerrodette 1986) or 1987 (Reddy 1989), and the 1981-88 trend (Fig. 2) shows a significant increase ($r = 1.05$, $P < 0.001$).

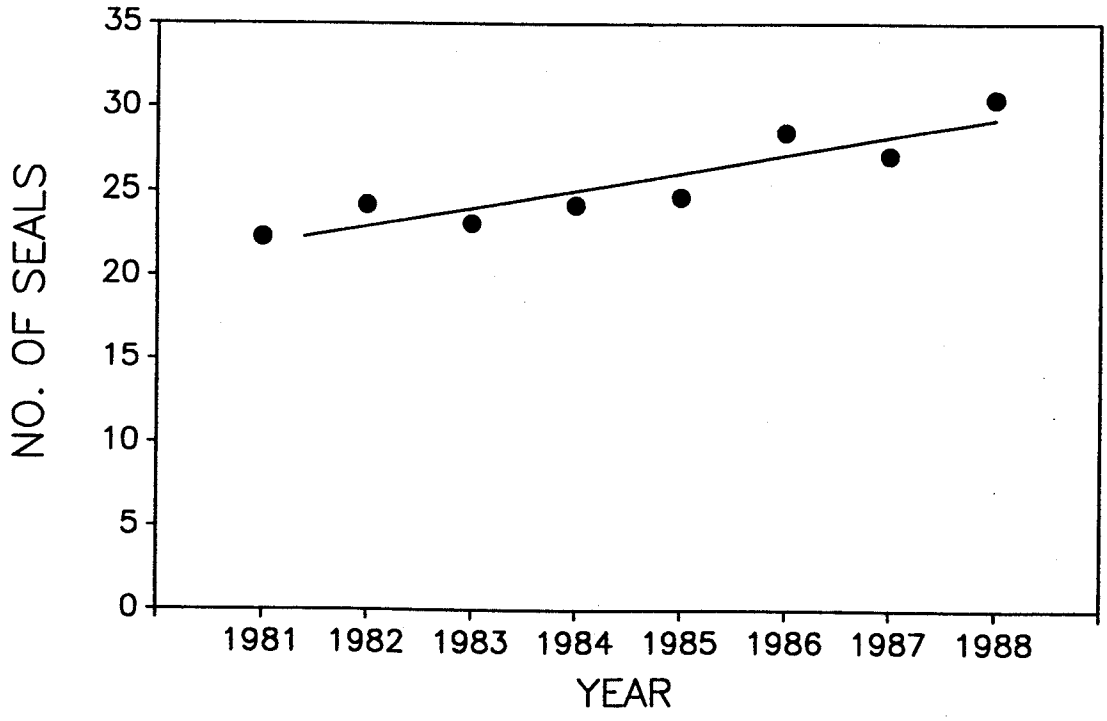

Figure 2.--April-July mean beach counts of Hawaiian monk seals at Kure Atoll. Line is least squares regression fit to annual means.

Table 1.--Average number of seals per sector, sector length, and density of seals for a total of 54 atoll-wide counts at Kure Atoll, 1988 (M = male, F = female, and U = unknown).

Location	Adult			Subadult			Juvenile			Pup			Total	Non-pup total	Sector length (km)	Density (non-pups/km)
	M	F	U	M	F	U	M	F	U	M	F	U				
Green Island																
Sector 1	0.3	0.2	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.8	0.7	0.585	1.2
Sector 2	1.6	0.9	0.7	0.9	0.8	0.6	0.0	0.3	0.1	0.2	0.1	0.0	6.1	5.9	1.275	4.6
Sector 3	0.7	0.6	0.3	0.4	0.8	0.2	0.0	0.0	0.0	0.1	0.1	0.0	3.0	3.0	0.744	4.0
Sector 4	0.6	0.1	0.1	0.1	0.4	0.1	0.0	0.0	0.0	0.1	0.1	0.0	1.5	1.3	0.660	2.0
Sector 5	0.7	0.1	0.2	0.3	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	1.6	1.6	0.523	3.1
Sector 6	0.7	0.3	0.2	0.5	0.3	0.2	0.0	0.0	0.0	0.3	0.1	0.0	2.8	2.4	0.957	2.5
Sector 7	0.2	0.3	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.3	0.1	0.0	1.3	0.9	0.360	2.5
Sector 8	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.3	0.2	0.465	0.4
Shark Islet	0.5	0.1	0.4	0.4	0.4	0.2	0.0	0.1	0.0	0.0	0.0	0.0	2.1	2.1	NA	NA
Sand Islet	1.8	0.3	0.8	0.7	1.4	0.6	0.1	0.0	0.0	0.0	0.0	0.0	7.1	6.8	NA	NA
Stark Reef	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	NA	NA
Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	NA	NA
Head start pen	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	2.9	0.0	3.3	0.4	NA	NA
Total	7.3	2.9	2.9	3.6	4.5	2.1	0.2	1.7	0.3	1.3	3.3	0.0	30.0	25.4		

Sector use on Green Island by non-pups apparently was not uniform, with sector 2 being most used by seals (Table 1). Because the lengths of Sand and Shark Islets and Stark Reef varied throughout the study, density of seals was not estimated at those locations.

Tagging

Missing or broken tags on two seals were replaced (Table 2). Seven weaned pups also were tagged (Table 3).

Reproduction

Eight pups (five females and three males) were born (Table 3): Six were born on the southwest end of Green Island, and two were born within the off-limits area on the northeast side of Green Island (Fig. 1). Locations of four of the births are imprecisely known because they occurred prior to the arrival of NMFS staff and were reported by USCG personnel. Seven of the pups survived to weaning.

One male pup (ID KF78) was abandoned by its mother 4 days after birth. The mother (ID K205) had incurred two large dorsal wounds (see Injuries) shortly before parturition. When the mother and pup were first observed near the vegetation line on the afternoon of 8 April, the mother was lying on her side presenting her ventrum to her pup. An adult male was less than 10 m away. The pup vocalized constantly and crawled around and away from the female, at one point moving as far as 12 m from her. The female then rolled onto her ventrum and vocalized, and the pup returned.

The mother-pup pair was observed intermittently from 8 to 11 April: The female was usually lying on her ventrum, and only once was she observed lying on her side presenting her nipples to the pup for suckling. The pup actively solicited nursing from the mother but was never observed suckling. The female remained tolerant of an adult male (ID K605) which was usually within 5 m of her and the pup. On the morning of 12 April, the pup was found alone on the beach near the vegetation. It was collected and maintained in the protective enclosure, but died 12-24 hours later (see Mortalities).

Table 2.--Tags replaced on Hawaiian monk seals at Kure Atoll, 1988 (M = male; F = female).

ID No.	Size	Sex	Old tag No.		New tag No.		Reason for replacement
			Left	Right	Left	Right	
K515	Subadult	F	K00	K06	K00	K16	Tag missing
KL01	Subadult	M	L01	L02	L12	L11	Tags broken

Table 3.--Summary of Hawaiian monk seals born at Kure Atoll, 1988.

ID No.	Tag No.[a] L	Tag No.[a] R	Sex[b]	Birth Date	Birth Sector	Weaning Date	Weaning Sector	Nursing period (days)	Tagging date	Measurement (cm)[c] AG	Measurement (cm)[c] SL	Weight (kg)	Mother ID No.
KF70	F70	F71	M	2/3-6[d]	6	3/12-14	6	35-40	3/15	112.0	133.0	NA	K134
KF72	F72	F73	F	2/3-6[d]	6	3/16	7	39-42	3/16	117.0	124.0	74.5	K143[e]
KF74	F74	F75	F	2/3-6[d]	6	3/16	7	39-42	3/16	118.0	137.0	94.5	K186[e]
KF76	F76	F77	F	2/16-23[d]	6	3/28	6	34-41	4/1	108.0	131.0	66.4	K083
KF78[f]	--	--	M	4/8	2	--	--	--	--	--	--	--	K205
KF80	F80	F81	M	3/14	6	4/26	7	43	4/26	110.0	123.0	NA	K024
KF82	F82	F83	F	4/2	2	5/5	4	33	5/5	103.5	131.0	71.4	K050
KF84	F85	F84	F	6/9	7	7/19	7	40	7/20	128.0	133.0	89.1	K251

[a]L = left; R = right.
[b]F = female; M = male.
[c]AG = axillary girth; SL = straight length (see text).
[d]Birth reported by U.S. Coast Guard.
[e]Likely pup exchange.
[f]Died 13 April 1988.

Table 4.--Adult female Hawaiian monk seals parturient at Kure Atoll, 1988.

Mother ID No.	First identification		Years known previously parturient	Age (years)	Pup ID No.
	Year	Size			
K024	1980	Adult	1981, 83, 84	13 +[a]	KF80
K050	1981	Pup	1987	7	KF82
K083	1981	Pup	Possibly 1987	7	KF76
K134	1982	Pup	None	6	KF70
K143	1982	Pup	None	6	KF72
K186	1982	Subadult	1985, 1987	9-11[a]	KF74
K205	1982	Subadult	None	9-11[a]	KF78
K251	1982	Subadult	1984	9-11[a]	KF84

[a]Assumes seal does not give birth at less than 5 years old.

All eight of the parturient females were recognized on the basis of scars or hind flipper tags, and information on their ages and pupping histories is available (Table 4). Four of the females had been temporarily maintained as pups in the Kure Atoll head start enclosure in 1981 or 1982. Ages of non-tagged seals were estimated with the assumption that an adult-sized seal is at least 5 years old and that a subadult-sized seal is 3-5 years old. Pupping histories may be incomplete: In 1987, two pups were born and died before biologists arrived at Kure Atoll, and the identities of the mothers are therefore unknown.

Captive Maintenance Program

The five female seals born at Kure Atoll in 1988 were maintained in the protective enclosure for 64-190 days. The first seal was captured on 16 March; all seals were released on 20-21 September. The enclosure was partially dismantled on 21 September, and the wire mesh and iron T-posts on the beach were completely removed on 19 October. Steel pipe stanchions used to support the mesh in the water were left in place.

During the night of 19 August, one pup (ID KF72) escaped through a gap underneath the wire mesh where sand had eroded during a strong overnight wave surge. The pup was seen in the immediate vicinity of the pen at midday on 20 August but could not be recaptured at that time. At about 1400 on 21 August, she was found asleep at North Point on Green Island and was recaptured and returned to the enclosure.

The yearling seal (ID KN88) was brought from Honolulu to Kure Atoll on 22 March, held in the head start enclosure for 52 days, and released on the morning of 12 May. She was seen later the same afternoon investigating a reef offshore of West Point on Green Island, but was not resighted thereafter in 1988 or in 1989 (NMFS unpubl. data).

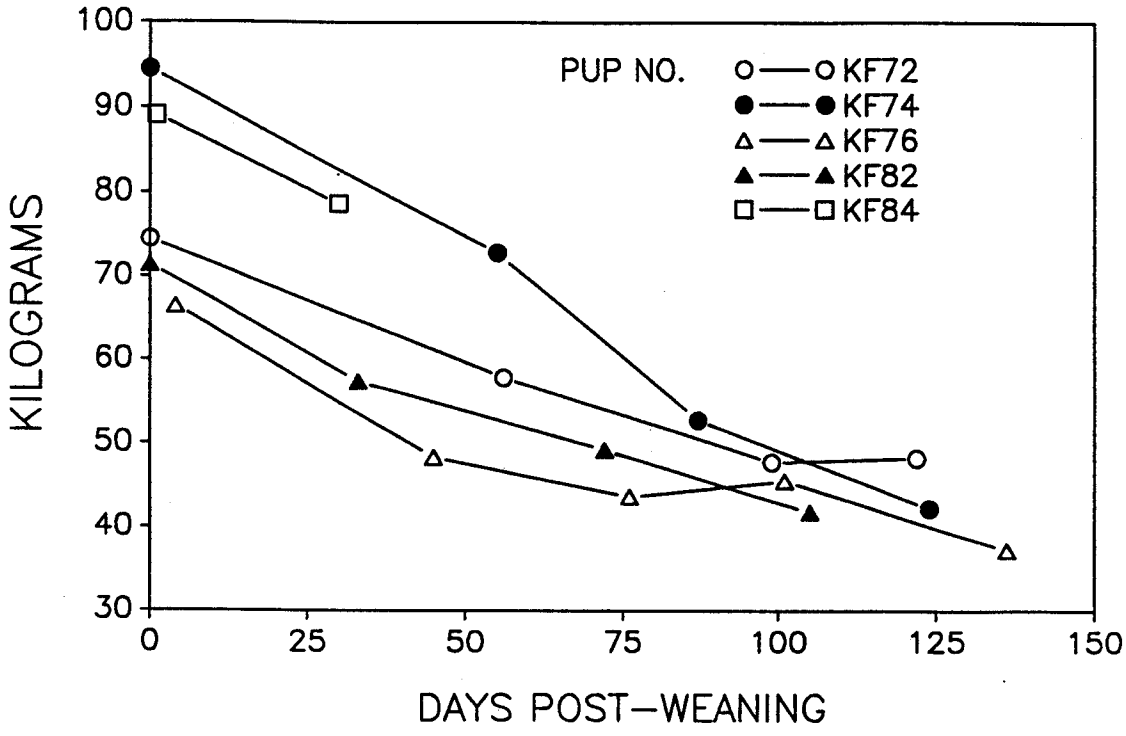

Figure 3.--Weights of weaned Hawaiian monk seal pups maintained in temporary captivity at Kure Atoll, 1988.

All pups lost weight while being maintained in the enclosure, despite the availability of live reef fish (Fig. 3). Weight loss is normal during the post-weaning fast of monk seals as they learn to feed. The pups generally showed little interest in fish during their first month after weaning, then progressed through phases of catching and mouthing fish, tearing them up, and finally consuming them. Prior to their release, all five seals were observed catching and eating live fish.

Injuries

Thirteen injuries to 12 seals were observed (Table 5). Probable causes were assigned to eight of the injuries: attacks by the cookiecutter shark, *Isistius brasiliensis*, attacks by adult males, attacks by other shark species, and shark attack or boat propeller. Five injuries were of unknown causes.

Table 5.--Injuries of Hawaiian monk seals at Kure Atoll, 1988.

Date	Size class[a]	Sex[b]	ID No.	Description of injury	Probable cause
				1987	
12/31[c]	A	U	--	10-cm-diameter circular wound, dorsal	*Isistius* sp.
				1988	
3/17	A	F	K024	Ventral lacerations	Unknown
3/12	S	F	Y290	7-9-cm-diameter circular wound, middorsal	*Isistius* sp.
4/2	A	M	--	Puncture or abscess, left hind flipper	Adult male
4/4	S	M	BK29	Abscess, right chest and axilla	Unknown
4/8	A	F	K205	Two gaping dorsal wounds	Adult male
4/13	A	M	--	Bleeding from penile aperture; no external wound	Unknown
4/22	A	M	--	5-cm-long abrasion on tail	Unknown
5/11	A	M	BL12	Two 15-cm-diamter circular wounds, one middorsal, one midventral	*Isistius* sp.
5/11	S	F	607	30 cm and 15 cm lacerations on rump	Shark or propeller
7/1	A	F	--	Several 2-cm-long dorsal lacerations	Adult male
8/11	S	F	Y290	10-cm-diameter circular wound, middorsal[d]	*Isistius* sp.
8/15	A	F	K009	Lacerations to chest, ventral neck, left front flipper	Shark

[a]A = adult, and S = subadult.

[b]F = female, M = male, and U = unknown.

[c]Reported by M. A. Harmon, U.S. Coast Guard.

[d]Injury more recent than healed injury of 12 March 1988.

Mortalities

One seal death was documented. A 5-day-old male pup (ID KF78) was found on 12 April to have been abandoned by its mother (see Reproduction). It was collected and transported to a sheltered area within the ocean-beach enclosure and was force-fed several smelt. On the night of 12 April, ambient temperature dropped and winds up to 40 kn swept the area. The following morning the pup was found dead.

Tag Resightings

Kure Atoll Seals

Of the 40 seals successfully weaned at Kure Atoll since 1981, 32 were resighted in 1988 (Table 6). Of the 21 female pups which have been included in the captive maintenance program, 18 were resighted, excluding a female sighted at Pearl and Hermes Reef (see below). Male pups have not been included in the captive maintenance program, but survival is nevertheless high, with 14 of 19 resighted.

Interatoll Movement

Movement of two seals between Kure Atoll and Pearl and Hermes Reef was observed (Table 7). A subadult male (ID BK29), originally tagged as a weaned pup at Pearl and Hermes Reef in 1985, was sighted throughout the spring and summer at Kure Atoll, having

Table 6.--Annual resightings of Hawaiian monk seal pups weaned and tagged at Kure Atoll, 1981-88 (M = male; F = female).

	No. of pups tagged		Resightings (No.) by year													
			1982		1983		1984		1985		1986		1987		1988	
Year	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
1981	4	5	4	4	4	4	3[a]	4	3[a]	4	2	4	3	4	3	2[b]
1982	1	3			0	3	0	3	0	3	0	3	0	3	0	3
1983	4	0					3	0	3	0	3	0	3	0	3	0
1984	4	2							3	2	2	2	2	2	2	2
1985	2	3									2	3	2	3	2	3
1986	1	0											1	0	1	0
1987	1	3													1	3
1988	2	5													2	5

[a]Excluded is one male (ID K026) sighted at Pearl and Hermes Reef in 1984 and 1985.

[b]Excluded is one female (ID K082) seen at Pearl and Hermes Reef in 1988 (see text).

Table 7.--Interatoll movement of Hawaiian monk seals at Kure Atoll, 1988 (S = subadult, A = adult, M = male, and F = female).

ID No.	Tag No.	Size	Sex	Movement from (date last seen)	Movement to (date first seen)
BK29	K28, K29	S	M	Pearl and Hermes Reef (25 August 1987)	Kure, Green Island (25 March 1988)
K082	614, 615, 045	A	F	Kure, Green Island (30 August 1987)	Pearl and Hermes Reef (22 June 1988)

been last sighted at Pearl and Hermes Reef on 25 August 1987 (NMFS unpubl. data). An adult female (ID K082), originally tagged as a weaned pup at Kure Atoll in 1981 and last sighted there on 30 August 1987, was sighted at Pearl and Hermes Reef several times during 22-29 June 1988 (B. Becker, Southwest Fisheries Science Center Honolulu Laboratory, National Marine Fisheries Service, NOAA, 2570 Dole St., Honolulu, HI 96822-2396, pers. commun., September 1988).

Entanglements

Five incidents of seal entanglement in marine debris were observed (Table 8).

Case 1. An adult female (ID K050) that had hauled onto a large pile of polypropylene line was found with several loops encircling her head and neck. The seal might have been able to escape by herself, since the loops were not tightly constricted. Nevertheless, the lines were removed, and the seal was released with no apparent injuries.

Case 2. The nursing pup (ID KF82) of the adult female (ID K050) entangled in case 1 became entangled in a large mass of nets and lines fouled on a reef approximately 50 m offshore. The pup was tightly bound by several loops around its neck, and escape was extremely unlikely. The lines were cut, and the pup was released with no apparent injury. The debris had washed onto the reef during a storm less than 1 week prior to the incident.

Case 3. A weaned female pup (ID KF74) in the ocean-beach enclosure became entangled about its neck by a fragment of green polypropylene webbing which had washed into the enclosure, probably the night before the incident was observed. The seal was not immobilized by the debris and was released uninjured.

Case 4. A weaned female pup (ID not recorded) being maintained in the enclosure became entangled about its neck by a fragment of polypropylene webbing. As in case 3, the fragment probably washed into the enclosure the night before the incident, and the webbing did not immobilize the seal, which was released uninjured.

Table 8.--Hawaiian monk seal entanglements in marine debris at Kure Atoll, 1988 (A = adult, N = nursing pup, W = weaned pup, and F = female).

Field No.	Date	Seal			Location of seal (sector)	Part of body entangled	Type of debris	Comments
		Size	Sex	ID No.				
1	4/13	A	F	KO50	2	Head and neck	Pile of line	Loosely entangled
2	4/22	N	F	KF82	2	Neck	Large pile of nets	Offshore reef
3	6/5	W	F	KF74	13	Neck	Net	Small net fragment
4	9/14	W	F	--	13	Neck	Unknown	Debris not retained
5[a]	10/2	W	F	KF84	12	Head and neck	Trawl net	Atoll perimeter reef

[a]Reported by U.S. Coast Guard.

Case 5. After NMFS personnel had departed Kure Atoll in late October, USCG personnel found a weaned female pup (ID KF84) entangled about the head and neck and immobilized by a large mass of polypropylene netting that was caught on a reef along the north edge of the atoll (S. Lewis, U.S. Coast Guard Loran Station Kure Island, FPO San Francisco, CA 96619-0006, pers. commun., October 1988). The location was approximately 3.5 km from Green Island and was accessible only by small boat. The USCG personnel took ashore the entire pile of netting containing the seal and released the animal, which was apparently uninjured.

Debris

A total of 577 separate pieces of debris weighing an estimated 1,195 kg were removed from beaches and nearshore reefs. Most (92.2%) pieces of debris were found on Green Island, with the remainder (7.8%) found on Sand and Shark Islets or in the lagoon. No debris was found on Stark Reef. Distribution of debris (by number per kilometer) was not uniform on Green Island (Fig. 4; $X^2 = 58.8, P < 0.05$); sector 1 accumulated less debris than the other sectors on Green Island.

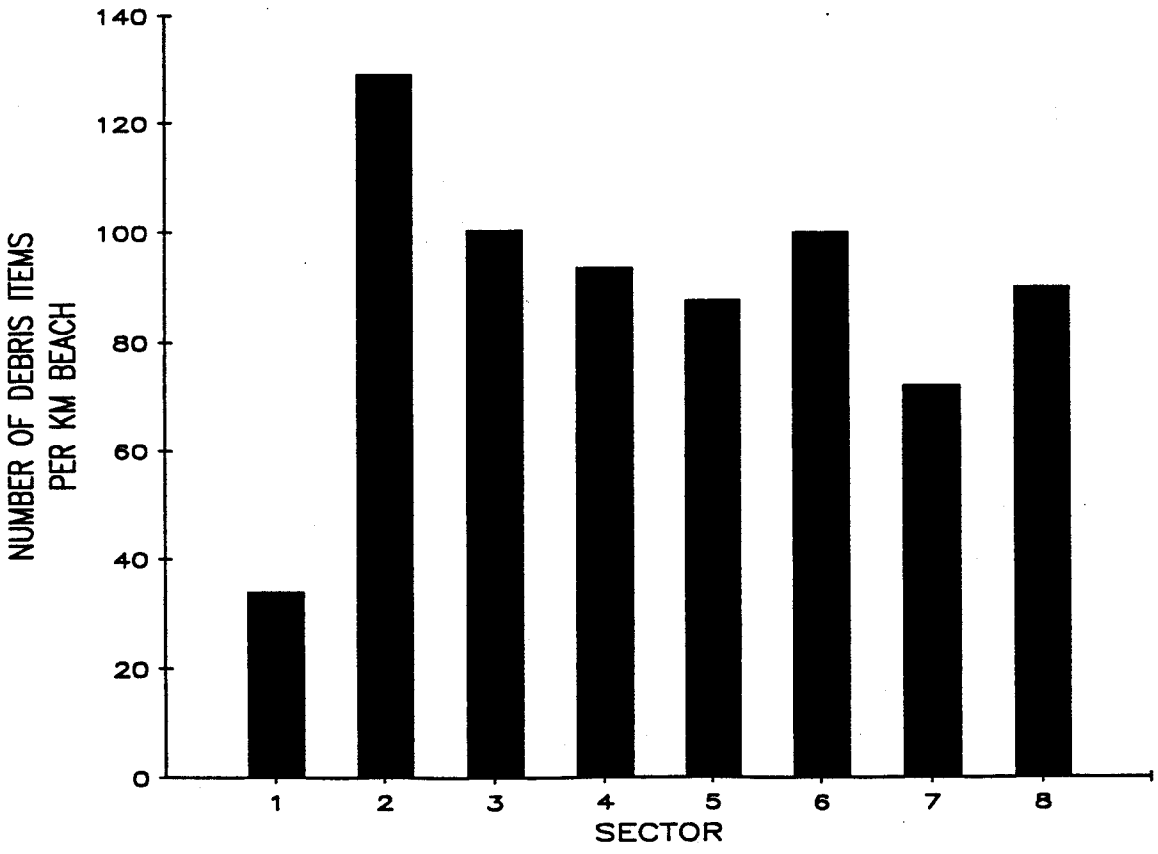

Figure 4.--Distribution of nets, lines, and other potentially entangling debris items at Green Island, Kure Atoll, 1988.

DISCUSSION

The equal ratio of immature to adult seals observed in 1988 represents a change from 1986 when the ratio favored immature seals (15.6:12.0, Reddy and Griffith 1988). This change in ratio represents a progression of immature seals into the adult size class, with less replacement by pups: Only one pup was born in 1986.

Seals continue to use Green Island approximately twice as much as the outlying sand islets, as first noted by Kenyon (1980) in 1980 and documented through 1987 (Reddy 1989). This is in contrast to patterns in 1968, when only 16.3% of an average beach count was represented by seals on Green Island (Kenyon 1972). The change in haul-out patterns has likely resulted from decreased human disturbance to the seals on Green Island since the late 1960s. In 1976, dogs were removed from Kure Atoll, vehicle use on beaches was prohibited, and the northern point of Green Island was placed off limits to personnel. More recently, briefings of personnel stationed at or in transit to Kure Atoll have resulted in an increased sensitivity to the seals.

Round trips between atolls by monk seals are not uncommon (Johnson et al. 1981; Johnson and Kridler 1983; Alcorn et al. 1988), and the interatoll movement of the adult female (ID K082) in 1988 may be the third transit this seal has made to Pearl and Hermes Reef from Kure Atoll [see Forsyth et al. (1988) and Reddy (1989) for previous transits]. This female has never been seen with a pup at Kure Atoll, but it is possible she gives birth at Pearl and Hermes Reef (where observer effort is less) and subsequently returns to Kure Atoll. Movement of seals between islands shortly after giving birth has been documented (Alcorn 1984).

The abandonment of a neonate pup by its mother and the resultant mortality may have been due to the recent injury the mother had received. The female was unusually tolerant to the proximity of an adult male seal shortly after parturition, and her nonresponsiveness even when the neonate pup crawled 10 m away is not consistent with previous observations of one author (JRH). Similar circumstances resulted in the death of a pup at Laysan Island in 1985 (Johanos and Austin 1988).

Pup abandonment led to the female using her physiological resources for tissue regeneration rather than for lactation, a process which may have adaptive significance. Nursing to term by an injured mother may cause her to become weakened, and the pup to be underdeveloped at weaning because of reduced milk production. By utilizing her resources for healing rather than attempting to rear a pup that might have died anyway, the female helped ensure future reproductive success.[2] Reproductive success, as measured by pup survival, is known to be lower among northern elephant seals, *Mirounga angustirostris*, that have received recent shark bites (Ainley et al. 1981), probably because injured females partition their reserves between healing and nursing a pup.

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[2] The female successfully raised a pup to weaning in 1989.

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APPENDIXES

Appendix A.--Itinerary for 1988 field activities at Kure Atoll.

Date	Itinerary
2/23	J. Henderson visits for a day to identify parturient females and determine sex of pups.
3/10	M. Finnegan, R. Westlake, and Henderson arrive; construction of pen begins.
3/13	Pen is completed.
3/15	Seal censuses begin.
3/22	L. Glennon arrives with yearling seal (ID KN88); Glennon and Henderson depart.
4/04	Henderson arrives; Westlake departs.
5/12	Yearling seal (ID KN88) is released from head start enclosure.
5/17	M. Breese arrives; Henderson departs.
5/31	R. Forsyth, M. Grimes, and J. Kluss arrive.
6/01	Finnegan and Forsyth depart.
6/14	C. Wilburn arrives; Grimes departs.
6/28	S. Lyons arrives; Wilburn departs
7/12	T. Gerrodette and S. Vlachos arrive; Lyons and Kluss depart.
7/26	B. Becker arrives.
7/27	Gerrodette and Vlachos depart.
8/09	Glennon and Henderson arrive.
8/10	Becker departs.
8/23	P. Ching and M. Costa arrive; Glennon and Henderson depart.
8/20	Pup (ID KF72) escapes from the head start enclosure.
8/21	Pup (ID KF72) is captured and returned to the enclosure.
9/08	B. Choy arrives; Ching and Costa depart.
9/16	Seal censuses are terminated.
9/20	Pup (ID KF72) escapes from enclosure and is considered released.
9/21	Henderson, S. Minasian, R. Morris, and B. Winning arrive, head start enclosure is partially dismantled, remaining pups (ID KF74, ID KF76, ID KF82, and ID KF84) are released, and all four personnel plus Choy depart.
10/19	D. Alcorn and Henderson arrive; pen is completely dismantled.
10/20	Alcorn and Henderson depart; field effort is terminated.

Appendix B.--Summary of atoll-wide census counts of Hawaiian monk seals, by size and sex, at Kure Atoll, 1988 (M = male, F = female, and U = unknown).

	Adult			Subadult			Juvenile			Pup			Total		
Date	M	F	U	M	F	U	M	F	U	M	F	U	Non-pup	Pup	Grand
3/15	10	2	7	6	6	0	0	3	0	2	1	0	34	3	37
3/17	8	4	3	3	5	1	0	1	1	2	3	0	26	5	31
3/19	10	4	3	3	6	0	1	3	1	2	3	0	31	5	36
3/21	8	2	2	6	6	1	0	1	0	1	2	0	26	3	29
3/23	10	3	1	3	5	2	0	3	0	1	3	0	27	4	31
3/25	10	2	2	2	3	2	0	2	0	2	2	0	23	4	27
3/28	7	2	4	2	3	1	0	2	0	1	2	0	21	3	24
3/30	7	2	3	4	6	4	0	2	1	1	2	0	29	3	32
4/01	9	3	2	4	6	1	1	4	0	2	2	0	30	4	34
4/04	8	1	3	2	2	0	0	1	2	1	4	0	19	5	24
4/06	9	4	1	3	2	0	0	2	0	2	3	0	21	5	26
4/08	10	5	2	4	6	0	1	2	0	2	4	0	30	6	36
4/11	9	5	2	3	5	0	1	2	0	3	3	0	27	6	33
4/14	7	7	5	4	6	2	0	4	0	1	4	0	35	5	40
4/16	7	4	1	0	4	6	0	2	1	2	4	0	25	6	31
4/18	6	4	0	3	2	2	0	2	0	2	3	0	19	5	24
4/20	11	4	1	7	9	1	0	3	0	1	4	0	36	5	41
4/22	13	4	4	7	6	0	0	4	0	2	3	0	38	5	43
4/25	7	4	2	2	5	2	0	4	0	2	4	0	26	6	32

Appendix B.--Continued.

Date	Adult			Subadult			Juvenile			Pup			Total		
	M	F	U	M	F	U	M	F	U	M	F	U	Non-pup	Pup	Grand
4/27	7	4	3	1	4	3	0	3	0	2	3	0	25	5	30
4/29	7	2	4	5	5	2	0	4	0	2	4	0	29	6	35
5/02	12	7	2	6	5	3	0	2	0	2	3	0	37	5	42
5/04	7	4	0	6	2	1	1	4	0	2	3	0	25	5	30
5/06	7	5	4	2	5	1	0	3	0	1	4	0	27	5	32
5/09	9	1	2	5	5	3	0	2	0	1	4	0	27	5	32
5/11	6	4	1	2	5	3	0	2	0	1	3	0	23	4	27
5/13	10	2	1	2	9	1	0	2	0	1	4	0	27	5	32
5/16	7	4	2	6	4	3	0	1	1	0	4	0	28	4	32
5/18	10	6	3	8	6	2	0	2	1	1	4	0	38	5	43
5/20	5	2	2	2	7	3	0	2	0	1	4	0	23	5	28
5/23	7	4	2	3	8	2	0	1	0	1	3	0	27	4	31
5/25	6	4	1	6	5	2	0	1	0	1	4	0	25	5	30
6/22	5	1	2	3	2	2	0	0	0	0	1	0	15	1	16
6/26	7	3	2	2	7	3	0	0	0	0	5	0	24	5	29
7/01	6	2	3	4	5	1	0	1	0	0	5	0	22	5	27
7/03	4	0	3	3	4	0	0	1	0	0	4	0	15	4	19
7/10	5	2	4	2	4	1	0	0	0	0	4	0	18	4	22
7/15	1	1	1	6	3	6	0	1	1	1	3	0	20	4	24

Appendix B.--Continued.

Date	Adult			Subadult			Juvenile			Pup			Total		
	M	F	U	M	F	U	M	F	U	M	F	U	Non-pup	Pup	Grand
7/18	6	3	0	3	7	4	1	2	0	0	5	0	26	5	31
7/21	3	0	1	4	4	2	0	1	0	1	5	0	15	6	21
7/25	4	3	3	5	4	2	1	1	1	1	3	0	24	4	28
8/08	6	2	2	1	3	1	0	1	0	1	4	0	16	5	21
8/11	7	3	6	2	1	1	0	1	0	2	5	0	21	7	28
8/13	10	2	1	3	3	2	1	1	1	1	2	1	24	4	28
8/15	9	2	2	3	2	0	0	1	0	1	3	0	19	4	23
8/18	9	1	1	2	0	1	0	1	0	2	0	0	15	2	17
8/21	8	2	6	3	5	2	0	0	0	2	4	0	26	6	32
8/25	2	2	6	4	0	1	0	1	0	1	1	1	16	3	19
8/28	2	1	9	4	2	3	0	0	2	1	2	0	23	3	26
8/31	9	2	3	3	1	2	0	2	0	1	5	0	22	6	28
9/03	5	2	8	3	3	4	1	0	1	2	5	0	27	7	34
9/12	6	3	4	3	4	4	0	0	1	1	1	0	25	2	27
9/14	6	4	6	5	9	5	1	0	0	2	1	0	36	3	39
9/16	6	3	9	3	6	10	1	1	0	1	5	0	39	6	45
Mean	7.3	2.9	2.9	3.6	4.5	2.1	0.2	1.7	0.3	1.3	3.3	0	25.4	4.6	30.0

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